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AUTHOR Norman, Donald A.
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ABSTRACT

This paper describes an experimental course in which the author taught students to improve their learning skills. It is a first step toward constructing a systematic body of knowledge about learning strategies. The course covered four topics, chosen because they were complex enough to require several weeks to make progress, but simple enough that some measurable level of skill would indeed be acquired. Topics were playing the soprano recorder; computer programing; playing bridge; and the history of the American Civil War. In addition to describing the course, the author discusses some of the learning principles he teaches. He emphasizes the need to instruct students about their own mental processes, including short-term memory limitations and the need to cluster or "chunk" related concepts. He also argues that there are at least three modes of learning: accretion, restructuring, and tuning. These concepts can be used to help students analyze their own learning. (Author/BP)

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Teaching Learning Strategies

Donald A. Norman

University of California, San Diego

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Donald A. Norman

University of California, San Diego

Although students spend much of their time learning new topic matters, they receive remarkably little training in the process of learning. I have been teaching an experimental course to students in an attempt to improve their learning skills, and much of this paper is derived from my experiences with this course. My goal is to construct a systematic body of knowledge about learning strategies that can both be taught to students and also contribute to our knowledge of learning. Unfortunately, what I now have seems more like an assortment of tricks and gimmicks, some useful, others speculative. There is not yet any cohesive body of knowledge about how one should learn, but it is time that psychology developed one.

The First Principles

Let me start by stating some of the simple ideas I have tried to give to students. Later, I will give a more comprehensive list, but to get started, let me cover what I consider the basic, first principles that students should acquire. Perhaps the most important thing is to instruct students about their own mental processes. Here there are several goals. First, one hopes to replace the rather naive folk psychology of the students with a

more realistic statement of mental processes. Even if the principles taught them are only approximations to the actual mechanisms, they must certainly be superior to the naive beliefs held by many students. For example, many students believe that the best way to "memorize" something is to say it over and over again to themselves -- to rehearse it. But rehearsal is one of the poorest methods for acquiring information, and a little instruction about memory processes, especially about the problems of memory retrieval, can rather quickly lead to slight improvements in memorization techniques. Larger improvements require more study and work, but the literature on mnemonic methods and on depth of processing indicates that large improvements can indeed be made.

In similar fashion, students can gain by being told about short-term memory limitations and the need to cluster or "chunk" related concepts. They must learn to distinguish between the great ease with which they can recall something from short-term memory and the difficulty of later recall. Students gain by realization that learning is difficult, that thousands of hours may be required for "automatization" of necessary skills, that periods of little apparent improvement occur, and that other students have similar difficulties. One of the points that seems to appeal most to students is the simple statement that learning is hard, that it should be hard, and that it is hard for everyone.

In a recent analysis of the learning process, Rumelhart and I

(Rumelhart & Norman, 1977) argued that there were at least three different modes of learning: accretion, restructuring, and tuning. Even if these ideas should prove wrong (or, more likely, oversimplified), I have found that students benefit when they try to analyze their own learning processes and to identify which mode of learning they are engaged in at any moment. They are told that accretion (the acquisition of knowledge into existing memory structures) is a never-ending process, for complex topics are rich in the amount of knowledge that they contain. The students are told that restructuring (the formation of new conceptualizations appropriate to the new topic matter) is an infrequent event, but absolutely essential for true understanding of the material. And they are told that tuning (the automatization of the knowledge structures) requires hours of practice, but that succesful use of knowledge requires automatic access to the concepts. Tuning minimizes the short-term memory load, thus allowing more powerful problem-solving to take place.

> Think of learning the multiplication tables (the students are told). Simply understanding the principles of multiplication is not enough, although when you first were exposed to multiplication, you might have been tempted to stop at that point. But knowing the principles and using them well are two different things. It would be difficult to do algebra or calculus (or to solve any real problem in a grocery store) if you had to

derive the answer each time you needed to know a product. The multiplication tables should be so well tuned that the answer to any simple problem appears effortlessly, without using any mental resources. Moreover (the students are informed) in times of stress, the mental resources available are reduced, and unless knowledge is well automated, performance will suffer over what can be done in more relaxed situations. Stress occurs in emergency situations (pilots, the students are reminded, learn to automate emergency procedures through many hours of practice in simulated emergencies). Stress also occurs during examinations (a point more relevant to the student taking a course). So, don't just look at your homework problems and decide you understand them. Do them. Do them until you can work them in your sleep. Then you will breeze through exams (and have a better knowledge structure besides).

The Course

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The course was structured so that most of the time was spent actually learning things. Four different topics were studied. The choice of topics was governed by a desire to have them be complex enough that several weeks would be required to make progress, but simple enough that some measurable level of skill would indeed be acquired. The four topics were:

1. Playing the soprano recorder. We used simple, plastic recorders and several standard beginning texts on the recorder. At the end of two weeks, the students could play simple tunes.

2. Computer programming. We used a special language (called FLOW) that is especially easy to learn. The facilities came from the experimental facilities developed for my research project on the study of learning, and this course was thereby closely integrated with the research.

3. Bridge playing. This topic, picked by the students, was learning how to play contract bridge. The choice seemed to work well, for the game is complex enough to demand considerable learning (and practice). Fortunately, we had a graduate student available who was an

expert tournament player, and he acted as a tutor in the first sessions.

4. The history of the American Civil War. This too was a topic studied in considerable detail by my research project, so we had a large amount of supplementary material, maps, games, and reference material. Also, several of us were reasonably expert at teaching the battles of the war, especially of the Mississippi River campaigns.

The students divided up into groups. Each group spent two weeks learning one topic. Then, they wrote a group report, with the emphasis to be on the learning, not the course content. The reports were circulated to the whole class and were discussed. I tried to point out learning principles.

Then, each group learned a new topic for two weeks, being tutored in the new topic by the group that had learned it in the previous session. Again, there were reports and class discussion at the end of the second topic, this time with the added perspective of having acted both as a teacher and a learner in the preceding two weeks.

Finally, the cycle repeated once more, with the groups all learning a third topic, being taught by the people who had learned the topic the first time. Thus, each group learned three dif-

ferent topics and taught the same topic twice, to two different groups. We debated the wisdom of teaching the same topic twice rather than teaching a new topic each time, but we decided that the virtues of having a second experience of teaching the same material outweighed the virtues of being able to teach a second topic.

The repitition seemed worthwhile. Students have not had much experience teaching entire topic matters, and they were unprepared for the advance organization and the depth of knowledge required of a good teacher. By having them teach the same topic for a second time they were able to have sufficient time to prepare properly. They also were able to compare their two teaching experiences. Had they switched to a new topic for the second teaching, their ability to compare and contrast the two experiences would have been confounded by the change in topic matter.

All along, I tried to explain how the mind works, teaching a simplified version of contemporary knowledge of memory, mnemonic strategies (as in any of the popular books on how to remember), the tactic of asking oneself questions about the material being learned, levels of processing, the need to preview, skim, and summarize reading material, and so on.

It is difficult to judge the success of the course. Next year I will do it differently. I will give more excercises. For example, using a technique that I learned from Wendy Moore (who

teaches a similar course at the University of Houston), I will pass out papers to the students and have them practice skimming, reading, asking questions about the material just read, and summarizing the papers in class. I may give examinations on the papers, to gain a record of the student's progress in developing skills. I did this once this year, and the experience seemed worthwhile. I will spend more time on the systematic teaching of memory and learning, and perhaps a week on the systematic learning of mnemonic strategies. This year I simply pointed out the issues, but as I myself kept saying: to learn you must do.

Outline of Learning Strategies

In this section I briefly list the basic learning strategies that were taught during the course. Some of the material described here is covered too briefly for decent understanding. Unfortunately, elaborations of these ideas are not possible (and although this paper would appear to be the logical spot, I am not quite ready to commit them to paper yet). I apologize for the problems the list will cause, but it seems better to include it than not.

Self knowledge

Memory structure (Short-term memory, long-term memory)

Attention limitations. Mental resources. Limited processing capacity. Limits of simultaneous attention. Effects of stress on performance (and on resources). Automatization.

Retrieval from memory Organization. Chunking in short-term memory. Depth of processing. Mnemonics.

Learning is hard. Learning takes time. (It is hard and time consuming for everyone.)

Skimming first, summarizing afterwards, is distasteful activity. You will not want to do it. But it pays off in the long run.

Learning styles. Know your preferences. Tailor the material towards your own strengths. Wholists, serialists. Verbal, visual. Generalist, specialist.

Task analysis

Analyze the task. Outline topic. Skim material first. Review afterwards. Understand purpose (your purpose, instructor's purpose).

Some principles

Depth of processing.

Critical confusion.

Skimming, reading, and summarizing.

Mathemagenic questions.

Forming relations, associations, analogies.

The power of oversimplification.

Erroneous concepts may be useful.

You need a framework.

Too much information can hurt you: attend to the important features. See the forest, not the trees.

Modes of learning.

Accretion.

Restructuring.

Tuning.

Teaching is a good learning strategy.

Spaced learning works better than massed (especially during accretion).

Levels of learning.

Skimming versus reading.

Summarizing versus reading.

The multiple pass strategy of reading and learning. Students at different stages of knowledge require different instructional material and different strategies for the very same topics. Be prepared to read and re-read. Read with a purpose. Read with questions in mind.

Why won't students preview and review?

One important problem remains. There seems to be good evidence that it is beneficial to skim a book or paper before reading it and to summarize it afterwards. The procedure makes good psychological sense, for it allows one to establish good conceptual structures prior to acquiring (accretion) the material in the text. Summarizing would appear to be a good memory check, insuring adequate depth of processing, making sure the concepts really have been acquired, and giving practice in their use. Because summaries help create structure and point out the important parts of material, the act of summary is itself a useful tool for

restructuring. Students agree, but they don't like to do these activities. I know the feeling, for I must force myself to do these things. Why? Why are so many effective learning acts so distasteful?

Concluding remarks

What has been learned from this experience? I think we know enough to teach students a more effective means of learning and studying. It is a peculiar thing that we expect students to learn and study effectively even though no one has ever taught them how to do so. We don't expect them to learn to read or write, do mathematics or understand literature without guidance: why should they be able to study without aid? It is time we tried to piece together what knowledge we do have and teach learning strategies.

Footnotes

The research reported in this paper and the techniques and methods discussed and taught in the class resulted from the studies conducted within my research project on the study of learning. Indeed, the course itself was integrated within those research efforts. I thank Serge Larochelle for his help during the course and for his comments afterwards. I thank Wendy Moore of the University of Houston for providing me with some of the course materials that she used in her course on "comprehension and retention." The research was supported by the Advanced Research Projects Agency and the Office of Naval Research of the Department of Defense and was monitored by ONR under contract No.: NC0014-76-0628.

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1. Books. I didn't use any books. I have been unable to find any good ones. I used excerpts from my own (the second editions of Memory and Attention, Norman, 1976, and Human Information Processing, Lindsay & Norman, 1977), which contain information on learning, on depth of processing, and on mnemonic strategies. I taught about mnemonics, depth of processing, and Rothkopf's notions of "mathemagenic" activities (see Rothkopf, 1970; also Anderson & Biddle, 1975). I made up a lot. There

really isn't very much available.

Three books seem likely future candidates. Higbee (1977) has a useful book on memory, and the book seems both a how-to-do-it course and an intelligent review of contemporary views of memory. Telford's (1968) student handbook for a introductory text has a 43 page section on how to study. And the book How student's learn by Entwistle & Hounsell (1975) seemed to be ideal, until I looked through it and discovered that one of the chapters had been written by me (for the Lindsay & Norman book). Obviously, this book, too, was deficient.

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